What is claimed is

1. A process for separating methane from a crude gas mixture comprising methane, carbon dioxide and heavy hydrocarbon compounds, the process comprising absorbing the heavy hydrocarbon compounds from the crude gas mixture with a carbon dioxide enriched composition to provide an intermediate gas mixture substantially free of heavy hydrocarbon compounds, separating the intermediate gas mixture with a selectively gas permeable membrane to form (a) a methane enriched product mixture and (b) the carbon dioxide enriched composition, and using the carbon dioxide enriched composition thus obtained for absorbing the heavy hydrocarbon compounds from the crude gas mixture.

2. A process for separating methane from a crude mixture comprising methane, carbon dioxide and hydrocarbon compounds, the process comprising the steps of

(A) compressing the crude gas mixture and removing water therefrom to produce a dehydrated feed gas comprising the methane, carbon dioxide and heavy hydrocarbon compounds,

(B) contacting in an absorber unit the feed gas with liquid absorbent condensed from a first stage permeate gas mixture comprising a major fraction of carbon dioxide, and substantially completely absorbing into the absorbent the heavy hydrocarbon compounds to form a liquid byproduct comprising carbon dioxide and heavy hydrocarbon compounds.

(C) separately removing from the absorber unit the liquid byproduct and an intermediate gas mixture comprising methane and carbon dioxide and which is substantially free of heavy hydrocarbon compounds,

(D) contacting in a first stage membrane separation unit the intermediate gas mixture with a feed side of a first membrane that is preferentially permeable for carbon dioxide relative to methane and causing the intermediate gas mixture to selectively permeate through the membrane to form said first stage permeate gas mixture on a permeate side of the membrane, and

(E) removing from the feed side of the membrane of the first stage membrane separation unit a first stage retentate gas mixture enriched in methane relative to the intermediate gas mixture.

3. The process of claim 2 in which the heavy hydrocarbon compounds are absorbed into the absorbent in a single pass through the absorption unit.

4. The process of claim 2 in which absorbing of the heavy hydrocarbon compounds into the absorbent occurs at a pressure greater than about 5.5 MPa (800 psi).

5. The process of claim 2 which further comprises

(F) contacting in a second stage membrane separation unit the first stage retentate gas mixture with a feed side of a second membrane that is preferentially permeable for carbon dioxide relative to methane and causing the first stage retentate gas mixture to selectively permeate through the second membrane to form a second stage permeate gas mixture, and

(G) removing from the second stage membrane separation unit a second stage retentate gas mixture enriched in methane relative to the first stage retentate gas mixtures.

6. The process of claim 5 which further comprises feeding the second stage permeate gas mixture into the dehydrated feed gas.

7. The process of claim 2 in which the step of contacting and absorbing comprises

(B-1) introducing the dehydrated feed gas into a vertically oriented, counter-current gas-liquid absorption column at a feed point of the column,

(B-2) condensing at least a major fraction of the carbon dioxide of the first stage permeate gas mixture to form a liquid carbon dioxide absorbent,

(B-3) feeding the liquid carbon dioxide absorbent into the absorption column above the feed point, and

(B-4) draining the byproduct from the absorption column.

8. The process of claim 7 in which condensing of the carbon dioxide is carried out within the absorption column.

9. The process of claim 7 in which the feed point is at an elevation above the bottom and below mid-height of the absorption column.

10. The process of claim 2 which further comprises condensing the first stage permeate gas mixture with a cooling medium at a temperature greater than about -5°C.

11. A system for producing refined methane from a crude mixture comprising methane, carbon dioxide and volatile organic compounds, the system comprising

(a) a dryer operative to remove water from the crude mixture and a compressor operative to increase pressure of the crude mixture to a pressure suitable for absorbing the heavy hydrocarbons,

(b) a counter-flow gas-liquid direct contact absorber downstream of the dryer and compressor and adapted to substantially completely absorb the heavy hydrocarbon compounds from the crude mixture into a liquid carbon dioxide absorbent and adapted to produce an intermediate gas mixture substantially free of heavy hydrocarbon compounds in a single pass,

(c) a first stage membrane separation unit having a first membrane that is preferentially permeable for carbon dioxide relative to methane, a feed chamber on one side of the membrane in fluid communication with the intermediate gas mixture, and a permeate chamber on a side of the first membrane opposite the feed chamber and which is adapted to receive a first stage permeate gas of intermediate gas mixture selectively permeated through the first membrane,

(d) a condenser operative to liquefy the first stage permeate gas, and

(e) a recycle transfer line in fluid communication between the absorber and the permeate chamber of the first stage membrane separation unit which is operative to transport the first stage permeate gas into the absorber.

12. The system of claim 11 in which the feed chamber is adapted to receive a first stage retentate gas, the system further comprising

(f) a second stage membrane separation unit having a second membrane that is preferentially permeable for carbon dioxide relative to methane, a feed chamber on one side of the second membrane in fluid communication with the first stage retentate gas, and a permeate chamber on a side of the second membrane opposite the feed chamber and which is adapted to receive a second stage permeate gas of first stage retentate gas mixture selectively permeated through the second membrane, and

(g) a return transfer line in fluid communication between the permeate chamber of the second stage membrane separation unit and the crude mixture upstream of the absorber and being operative to feed the second stage permeate gas into compressed and dehydrated crude mixture.